

Is the Time a Dimension of an Alien Universe?

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On the base of the hypothesis about a nature of the time as a dimension of alien Universe relation between alteration of time with coordinates $\frac{\partial t}{\partial x}$ and time t offered: $\frac{\partial t}{\partial x} = H_t t$. This relation is an analogy of the Hubble law in the time space. The consequence of it is additional redshift Z_{DT} depending on differences τ of times existence of the objects with redshift that are compared (t_0 is the time existence of more old object): $Z_{DT} = \frac{1 + \frac{\tau}{t_0}}{\sqrt{1 - (\frac{\tau}{t_0})^2}} - 1$. The redshift of Arp galaxies may

be explained if this relation is used and this explanation does not contradict Arp hypothesis about supernova explosions. Discussion a possibilities of experimental verification of the hypothesis is considered.

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I. INTRODUCTION

The appearance in recent years many variants of quantum gravity, including theories with change of signature sign, gravitational quantum tunnel transitions in the inflation phase, different methods of quantizing and so forth (see, e.g., a review in [1]) do not allow to choose the criteria to distinguish "right" theories from "wrong" ones. The situation is similar to that existed in the beginning of our century in physics, when Lee groups theory was invented and included as a special case the Lorenz sub-group but there were no convincing reasons to single out of it the Dirac equation. Now there is no a quite clear idea on the time nature which would permit to predict the phenomena whose experimental examination in its turn would help to judge its reliability. If there is any, it would be able to significantly narrow down the choice for possible quantum gravity theories. It is one of such "time models" that is discussed in the present paper. Treating time as a dimension of another universe with laws similar to those of our world, it gives the way to a number of experimentally phenomena, some of which are discussed in the paper.

II. INTERSECTING UNIVERSES HYPOTHESIS

Let us consider time to be one of dimensions of a three-dimensional space of another universe which adjoins to ours and penetrate into it by this dimension (see [2]). To do this, assume that at the "Big Bang" the quantum state of the early universe gave the birth to an ensemble of inflation formations with different values of Hubble constant $H = \frac{\dot{a}}{a}$ (a is the scale factor of the space elements of metric). This does not contradict to the contemporary conception of the world in the inflation universe models. Then a chains of initially three-dimensional formations

also could emerge, with one dimension penetrating into another one and thus making it four-dimensional. So, restrict ourselves to only such formations. Stress, that this formations are primordial three-dimensional but in addition there exist a "penetration" of one dimension of another formation (we shall call it "neighboring") into it. In other words, we are interested in only the formations having total number of dimensions being equal to four: three of them are "own" and the fourth one penetrated from another formation and is of different, generally speaking, origin. Thus, this fourth dimension belongs to both of the neighboring formations and is common to them. It is "own" to one formation and "foreign" to another. We shall refer to such formations as "universes". In the neighboring universe (whose the fourth dimension is) the situation would be the same. To its own three dimensions (one of which is common with the first universe considered) a new "foreign" dimension from another universe is added - either from that mentioned before or not. In the first case we have an isolated pair of universes, and in the second one have the chain of intersecting universes which can be closed and finite or open and infinite. If we are to suppose non-equal inflating of the three-dimensional volumes of this universes in regard to each other (because of different value a), the fourth dimension penetrated into a universe from another one can play the role of natural calibrating value while comparing the volumes and be treated as "time". In this case the dimension of "foreign" universe common to ours is time to us, but in the foreign universe the role of time is played by a dimension of an alien to it universe (either new one, or, probably, ours). Note, that this model does not reduce to the York theory (see [3]) or to the "scale" theories of time. Here time is not simply a scale factor but a dimension of origin and properties different from that of our three space dimensions, though it plays in its own universe role exactly the same as them. All what is needed for such treatment is a difference in expanding between the three "own" and the

fourth "foreign" dimensions. Therefore, from this point of view, time can be considered as a dimension of another formation and common to our universe but with properties different from that of our own three spatial dimensions and, hence, expanding unlike them. The concept of the expansion rate of the universe (as well as time and rate concepts themselves) are then defined by comparing the laws of changing three-dimensional volumes of neighboring universes having one common (the fourth to us) dimension. The four-dimensional interval of special relativity $ds^2 = dr^2 - c^2 dt^2$ in this case, at $ds^2 = 0$ will yield the rate of changing of our spatial coordinates in relation to t coordinate which characterize the alteration of the "spatial" dimensions of the other universe. Light velocity c in this terms is simply the difference between changing in own three-dimensional volumes of two neighboring universes. It appeared as a result of the Big Bang and can be exceeded in our space only at local but not at large scales. In the neighboring universe, provided validity after the phase of blowing a kind of special relativity condition like that of our world, we shall have $ds^{*2} = dt^2 - c^{*2} dr^2$, and, $c^* = c^{-1}$ from our point of view, in the simple case. What consequences arise from this hypothesis concerning the nature of time, based on existing of at least two such four-dimensional universes with one common dimension?

III. ANOMALOUS REDSHIFT BEHAVIOR

As the first consequence of the model proposed we shall discuss the red shift in the spectra of far star objects. Let the physical laws of nature be equal in the neighboring universes. Then in both of them, ours "spatial" and the other "temporal" the following Hubble laws can be written:

$$\frac{dx}{dt} = v_x = H_x x \quad (1)$$

$$\frac{dt}{dx} = v_t = H_t t \quad (2)$$

where v_x and v_t are the rates of scattering of star objects in the corresponding universes, H_x and H_t are the Hubble constants in them and x and t mean the distances between the objects in the "spatial" and "temporal" universes. One of three dimensions making in the "temporal" universe vector t penetrates into our universe and plays the role of time to us. We shall denote it as t , because only one component of t is common. Stress, that instead of the Hubble law (1) now one should take into account in addition to it the new relation (2), that is

$$v_t = H_t t \quad (3)$$

The physical sense of v_t is the rate of time alteration per distance unit and can be bound up with the time

passed since the star object was born in our universe. The Doppler wavelength shift $Z = (\lambda_0 - \lambda_e)/\lambda_e$ (here λ_0 and λ_e are wavelengths in the observer's frame of reference and in the object's own one) then should be calculated using (3) as well as (1). Denote it as Z_{DT} and Z_{DX} accordingly. If $Z_{DT} \ll Z_{DX}$ or $Z_{DT} \gg Z_{DX}$ then the resulting shift is simply their sum:

$$Z = Z_{DX} + Z_{DT} \quad (4)$$

For Z_{DT} , using (3) one easily finds

$$Z_{DT} = \frac{1 + \frac{v_t}{c^*}}{\sqrt{1 - \frac{v_t^2}{c^{*2}}}} - 1 \quad (5)$$

where $c^* = c^{-1}$. When $c^* = \alpha c^{-1}$, $\alpha = \text{const}$. Putting v_t from (3) into (5) and assuming, in virtue of similarity of the nature's laws in both of the universes, $H_t = H_0 c^{-1}$ we obtain (for $c^* = c^{-1}$)

$$v_e c^{*-1} = H_t t c^{*-1} = H_0 t (c^* c)^{-1} = \frac{t}{t_0} \quad (6)$$

with $t_0 = H_0^{-1}$ being the time since the universe formation and t is the difference between the birth time of the star objects of whose spectra redshift is investigated (i.e, $t = t_e - t_0$ or $t = t_0 - t_e$ depending on the sign of the expression). Then

$$Z_{DT} = \frac{1 + \frac{t}{t_0}}{\sqrt{1 - (\frac{t}{t_0})^2}} - 1 \quad (7)$$

and

$$Z = Z_{DT} + Z_{DX} \approx \frac{1 + \frac{v}{c}}{\sqrt{1 - (\frac{v}{c})^2}} + \frac{1 + \frac{t}{t_0}}{\sqrt{1 - (\frac{t}{t_0})^2}} - 2 \quad (8)$$

If the contributions of Z_{DT} and Z_{DX} into Z are comparable by value, it is not clear which way to calculate the Doppler shift in the direction to the observer is more preferable,

$$Z = Z_{DX} + Z_{DT}$$

or

$$Z = \frac{1 + A}{\sqrt{1 - A^2}} - 1 \quad (9)$$

where

$$A = \frac{\frac{v_x}{c} + \frac{t}{t_0}}{1 + \frac{v_x t}{c t_0}}$$

The first case corresponds to independent contribution of Z_{DT} and Z_{DX} , while (9) represents the attempt to add velocities of different origin (in different universes) in the direction to the observer (note, that velocity in the "temporal" universe is a vector only in that universe, but not in ours).

IV. NEW ENERGY -MOMENTUM RELATION FOR ALIEN NON-RELATIVISTIC PARTICLES?

As the second example we put the following question: whether a particle (with rest mass m_0) can penetrate from one universe into another (say, from ours to the neighboring or into our universe from elsewhere) and if yes, which energy it should possess? To answer it, let first write two Dirac equations for a free particle in our universe and in the other one:

$$\partial_\gamma \psi(x) = 0; (x = r, it) \quad (10)$$

$$\partial_\gamma \psi(x_t) = 0; (x_t = t, ix) \quad (11)$$

where γ means Dirac matrices. Energy eigenvalues for the particle then

$$E^2 = p^2 + E_0^2; E_0^2 = m_0^2 c^2 \quad (12)$$

$$P_t^2 = E_t^2 c^{*2} + P_{0t}^2; P_0 = m_0 c^* \quad (13)$$

Here the particle energy and momentum are written for our and the neighboring universes accordingly. Note, that momentum corresponds to the space derivative of wave function, that is $\partial\Psi/\partial r$ and energy corresponds to the time derivative $\partial\Psi/\partial t$. As space and time exchange their role while turning from one universe to the other, the derivatives also will exchange their role. That is, what we usually call "momentum" will behave like energy and vice versa. We shall keep the notations P for $\partial\Psi/\partial r$ and E for $\partial\Psi/\partial t$ though their sense in different universes may change and this fact is taken into account in (13).

If we may admit that when a particle tunneling from one universe into another its momentum remains, then $P_t = P$ and (12) takes the form

$$E^2 = (E_t^2 c^{*2} + P_{0t}^2) c^2 + E_0^2 \quad (14)$$

But in the neighboring universe $P_{0t} = m_0 c^*$ and in our universe momentum can be of any quantity. Therefore E^t turns into relativistic energy and can not be less than $E_0 = m_0 c^2$. Then from (14) follows an inequality for the particle energy

$$E > 2E_0 \quad (15)$$

This condition is necessary but not sufficient, because our assumptions require that vector momentum conservation law must realize. Probably, the validity of this law can be achieved only for a selected direction in our space or only near massive bodies which get the remainder energy and momentum. Nevertheless, the expression (15), in principle, can be examined experimentally, since it indicates on the possibility of an apparent violations of the laws of conservation of energy, charge, number of particles faster than $\sqrt{3}/4c$, which originates from the particles going out into another universe. For

massless particles (i.g., photons) this transition may reduce to a frequency renormalization (a simultaneous for all the frequencies "reddening"). Beside that, one can take into consideration a possibility for both mass and massless particles tunneling through a potential barrier of unknown nature which divided the universes since they was born. Discuss now some aspects of tunneling of quantum particles from one universe into another. If it is possible, no matter how small the probability of such a transition is, it seems that one can point out two observable consequences. The first of them is as follows. In the neighboring universe a free non-relativistic particle obeys the equation

$$i\hbar \frac{\partial}{\partial x} \Psi = \frac{\hbar^2}{2m_0 c^3} \frac{\partial^2}{\partial t^2} \Psi \quad (16)$$

therefore the relation between its energy and momentum will differs from that for a particle in our universe. Namely,

$$E = \sqrt{2E_0 c} \sqrt{p} \quad (17)$$

V. DOES INTENSITY OF RELIC RADIATION HAVE A SECOND MAXIMUM?

The second consequence observable appears from the relic radiation of the neighboring universe. This radiation, if tunneling through the barrier between the universes, can, in principle, be detected. Its frequency and wavelength can be calculated using the assumed earlier similarity of the physical laws in both of the universes. Thus, in the neighboring one the relic radiation wavelengths λ_{tr} (measured in seconds) will coincide numerically with the wavelength obtained in our universe λ_r . But while turning to our universe from the "foreign" one, the wavelength must be multiplied by the light velocity c . So, λ_r of the foreign relic radiation came to us is (in case $c^* = c^{-1}$)

$$\lambda_{rt} = \lambda c \quad (18)$$

Though in (18) the wavelength is very large (it corresponds to the frequencies of about $0,1 \text{ sec}^{-1}$), at the intensity curve of relic radiation background there will be an anomaly in this (or another) region, observed as a maximum with fast decreasing low frequency border. Whether it is possible to distinguish this maximum from the galaxies heat noise?

VI. IS THE REDSHIFT OF ARP GALAXIES CONSEQUENCE OF DIFFERENCES IN TIME EXISTENCE OF THEIR PARTS?

Very interesting problem is interpretation of large differences in value of redshift of different parts of Arp

galaxies [4]. All difficulties may be take of if use for explaining this the new relation (equation (7)) The hypothesis of Arp about explosion of supernova stars may be includes in this interpretation . The interpretation of redshift is: the different parts of Arp galaxies were borne in different times.

VII. FINAL REMARKS

In the frames of the model considered a number of other questions arises. Is our universe non-isotropic in relation to the direction of "foreign" dimension penetrating? Is there only a pair of universes or every dimension can penetrate into some universe or other making an infinite series of universes? If it is possible to send a particle into another universe in what time it will find itself when returned and so on. Apparently answering such questions can stimulate producing more complicated theories (including the proposed here as a special case) and further investigations the nature of time.

In conclusion we name again the main ideas and results.

1. The model of the "Universes" discussed treats the time as one of the dimensions of a "neighboring" Universes born together with ours and expanding by another law. The rate of expanding is calibrated by comparing the change in "own" three-dimensional volumes of the neighboring universes.

2. If we are to assume the similarity of the physical laws in different universes, then beside the Hubble law the analogous law is exist concerning to the rate of changing the time coursing in dependence on the time passed. This law allows to avoid some contradictions related to redshift in spectra of a number of anomalous far galaxies (including Arp galaxies).

3. The model considered gives way to a number of statements which can in principle be examined by experiment. Some of the consequences are briefly discussed: existing of relic radiation come from "foreign" universes; a possibility for non-conservation of energy, charge and number of particles with energies greater than $2E_0$ (because of leaving into the neighboring universes); anomalous dependence of energy upon momentum for non-relativistic particles of "foreign" origin.

All the results following from the model of Universe structure proposed, though it seems to be unlikely and leading to an unusual treatment of time, allow to hope for an experimental examination. Stress, the hypothesis about nature of time doe's non contradict the hypothesis of multifractal nature of time and space presented by author in [5]- [13]. Some results of multifractal theory of time and space coincide with results of hypothesis considered in this paper, but here was presented hypothesis that gives new look on the possible origin of time and its nature. As the last remark we once more pay attention on possibility to receive the results concerning the red-

shift if simple postulate the inhomogeneity of time flows and relation $\frac{\partial t}{\partial x} = H_t t$ without any explanations.

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